Axion Dark Matter

Cosmic Frontiers Workshop, FNAL March 2011
Very brief summary of axions at dark-matter section
March 24, 2011
Leslie Rosenberg, University of Washington

Axion Dark Matter (1)
First of all, is dark matter axionic or not?

Standard assumption: the structure formed from axionic or WIMP dark matter is the same.

But: Axions are a Bose condensate.

Produces coherent structures. E.g., organized caustics.

Long known: e.g., Ed Bertschinger, Pierre Sikivie, Tom Quinn

n-Body evolution is recent development

Will we know whether dark matter is a Bose condensate or not?

Current experimental status: search for this structure:

1. **Early Craig Hogan suggestion: lensing from caustics: Idea was to constrain width of phase-space sheet.**
2. **Study ensemble of spiral galaxy rotation curves.**
3. **Monoceros ring, etc.**
4. **Detailed image of caustics in our galaxy.**

There are major concerns about "gastrophysics"

But I predict that we will have to deal with this in 5 years or so.

Dark Matter (1) : Astrophysics Structure…some examples P. Sikivie figs

Overlay a bunch of scaled rotation curves…look for structure.

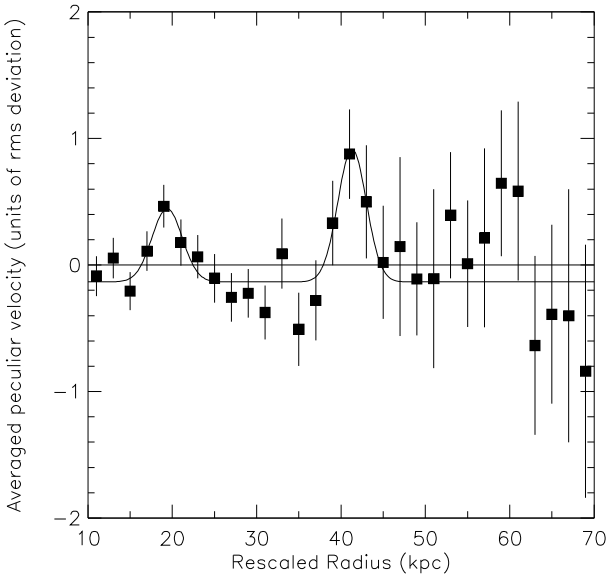
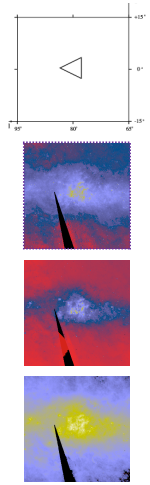
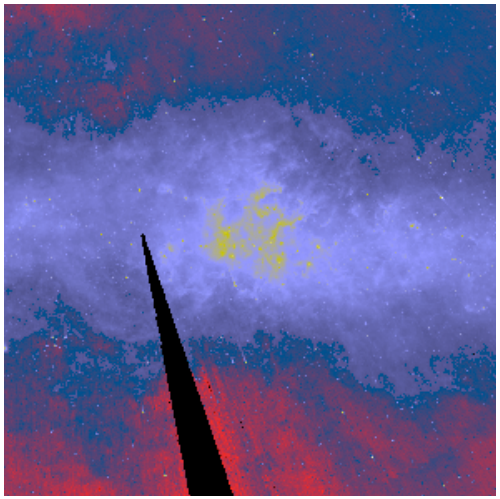


FIG. 1. Binned data for 32 galaxy sample, with peaks fi to Gaussians

We have shown that there is evidence for universa

IRAS view of where a caustic might be. (14 to 100 microns)





Dark Matter (2) : State of axion theory

State of QCD-axion theory relatively unchanged since Peccei-Quinn.

M. Turner, “Axions, the thinking person’s dark matter.”

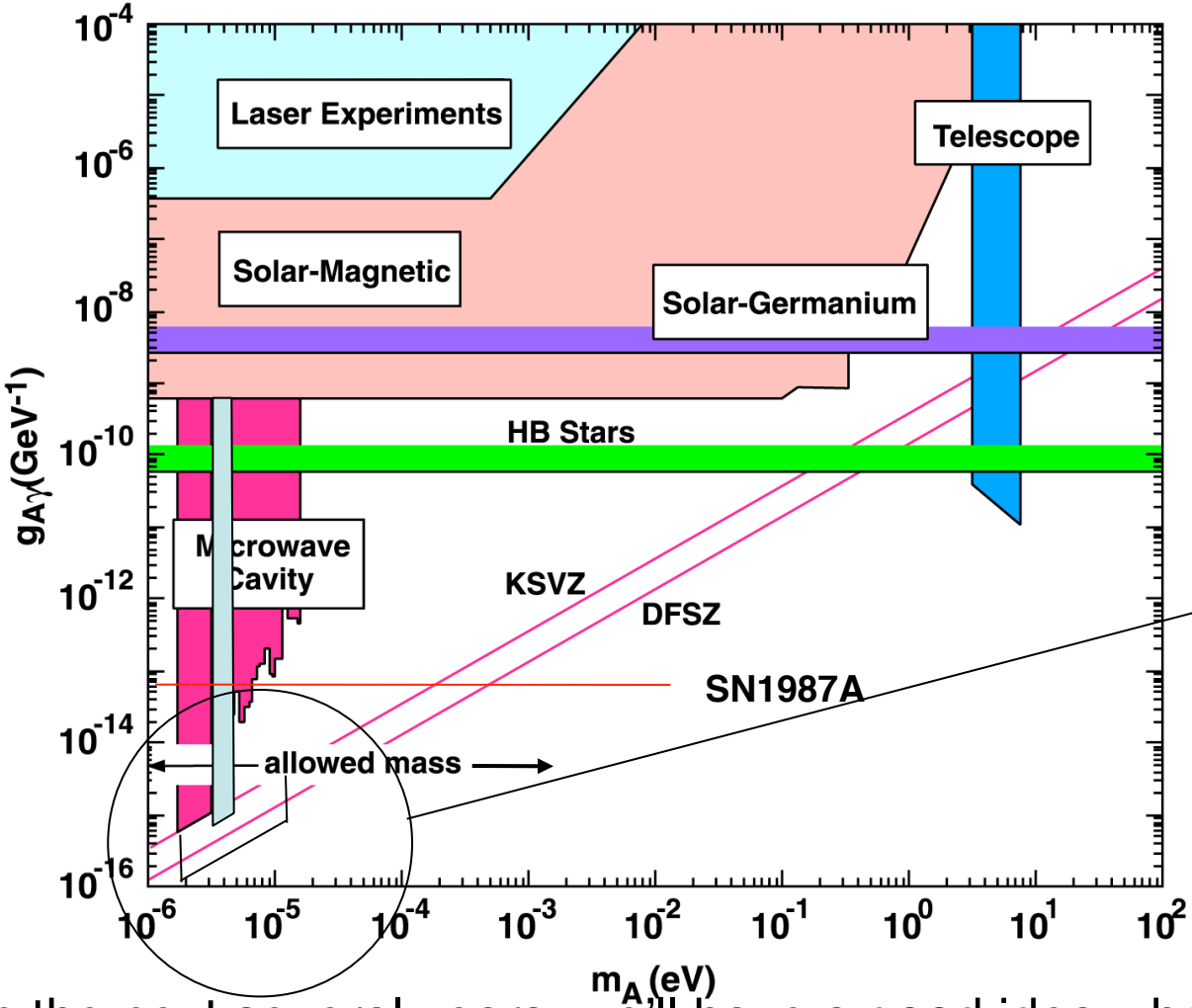
But axions (and axion-like particles) appear in other contexts;
e.g., strings.

The mass and couplings (to photons) are relatively constrained: QCD axion is highly constrained.

e.g., Svrcek & Witten “Axion Cosmology”
(1) The axion is as fundamental as the graviton;
(2) couplings cannot be too small.

Dark matter (3): Experiments

For the QCD axion, SN1987A is a major constraint



Reach of RF-cavity axion searches in next 2 years or so

In the next several years, we'll have a good idea whether or not the QCD-axion hypothesis is correct.